FINAL SUBMISSION
EXECUTIVE SUMMARY

OAKLAND ARMY BASE
OAKLAND, CALIFORNIA

BASEWIDE ENERGY SYSTEMS PLAN

PREPARED FOR

THE DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT
CORPS OF ENGINEERS

CONTRACT NO. DACA05-80-C-0118

PREPARED BY

SANDERS & THOMAS, INC.
AN STV ENGINEERS PROFESSIONAL FIRM
11 ROBINSON STREET
POTTSTOWN, PENNSYLVANIA

SANDERS & THOMAS.
AN STV ENGINEERS PROFESSIONAL FIRM

CONSULTING ENGINEERS. 11 ROBINSON STREET, POTTSTOWN, PA 19464.
PHONE 215/326-4600. CABLE: SANTOM, TELEX 84-6430.

April 12, 1983

U. S. Army Corps of Engineers
Sacramento District
650 Capitol Mall
Sacramento, CA 95814

Attention: Mr. Randy Redeen, Project Manager

Reference: Basewide Energy Systems Plan
Oakland Army Base, Oakland, California

Subject: Final Submission

Contract No.: DACA05-80-C-0118

Our Project No.: 05-8200

Gentlemen:

Enclosed is the Final Submission of the Basewide Energy Systems Plan for the Oakland Army Base (OARB). The Plan details projects that will enable the Base to meet the energy consumption goals of the Army Facilities Energy Plan.

The Plan consists of six components: 1) Executive Summary, 2) Report, 3) Appendix I, 4) Appendix II: Energy Conservation Measures Summaries, 5) Project Programming Documents, and 6) Increment F Study.

All comments have been reviewed and incorporated in the report, as appropriate.

This Plan is a valuable data base that can be used to develop additional projects as Army goals are revised and other energy conservation projects become viable.

We greatly appreciate the assistance, courtesy, and hospitality that was provided by OARB personnel. Their cooperation and insight considerably enhanced this report.

Thank you for this opportunity to be of continued service.

Sincerely,

SANDERS & THOMAS, INC.

David M. Jonik, P.E.
Project Manager

DMJ:mat
Enclosure

FINAL SUBMISSION
EXECUTIVE SUMMARY

OAKLAND ARMY BASE OAKLAND, CALIFORNIA

BASEWIDE ENERGY SYSTEMS PLAN

PREPARED FOR

**THE DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT
CORPS OF ENGINEERS**

CONTRACT NO. DACA05-80-C-0118

PREPARED BY

SANDERS & THOMAS, INC.
AN STV ENGINEERS PROFESSIONAL FIRM
11 ROBINSON STREET
POTTSTOWN, PENNSYLVANIA

PROJECT ABSTRACT

BASEWIDE ENERGY SYSTEMS PLAN
OAKLAND ARMY BASE

This analysis is undertaken to assist the Oakland Army Base (OARB) in meeting the goals established by the Army Facilities Energy Plan to reduce consumption by 20 percent by 1985.

Projects selected for implementation as a result of this analysis will enable OARB to achieve the 1985 goal. Total annual energy savings from implementing Increment A, B, and G projects will be approximately 75,000 MBTU's. The total cost of these projects is estimated at approximately $3.0 million.

The implementation of Increment F projects will result in an additional annual energy savings of 41,900 MBTU's per year at an implementation cost of $80,000. Total savings for all projects are estimated at 117,000 MBTU's at a cost of about $3.08 million.

DEFINITION OF TERMS

BENEFICIAL OCCUPANCY DATE (BOD)

The date a facility begins to operate.

BENEFIT-TO-COST RATIO (BCR)

The dollar savings (based on energy savings) realized over the life of the project divided by the nonrecurring capital investment (including design). BCR is a measure of project payback. A BCR of 1.0, for example, means that the projects initial capital investment will be recovered over its lifetime.

COST INDEX

Comparison of Energy Cost Indices for various years giving a chosen base year a value of 100.

CURRENT WORKING ESTIMATE (CWE)

The project's installation cost escalated to the year the project is designated for construction. Installation costs are non-recurring and include all labor and material, contractor costs, bond, contingency, SIOH, and escalation. Design costs are not included and must be added to the CWE to develop the total installed cost.

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

Military funded program for retrofitting existing DOD facilities to make them more energy efficient.

ENERGY CONSERVATION MEASURES (ECM)

Projects to conserve energy and/or costs through energy/manpower reductions.

ENERGY COST

Cost of Source Energy Consumed (obtained from utility bills).

ENERGY COST INDEX

Energy cost per square foot of building.

ENERGY MONITORING AND CONTROL SYSTEM (EMCS)

This is a computer-based control system used to achieve energy dollar savings through automatic control of building heating, ventilating and air conditioning (HVAC) systems. This includes implementation of various energy conservation measures, such as programmed equipment shutoff, programmed outside air shutoff, and equipment optimization, to reduce the total energy consumption of individual buildings, reduce energy distribution system losses and improve HVAC system capability.

ENERGY-TO-COST RATIO (ECR)

The Mega British Thermal Units (MBTU's) per year saved divided by the non-recurring capital investment (excluding design). ECR is a measure of the amount of energy savings related to the required capital investment. Acceptable ECR's should be lower each year since energy costs escalate faster than capital investment costs.

ELECTRICITY KWH INDEX

Quantity of electricity, expressed in kilowatt hours, consumed per square foot of building area per year.

ELECTRICITY ENERGY INDEX

Quantity of electricity, expressed in thousands of British Thermal Units, consumed per square foot of building area per year.

ELECTRICITY COST INDEX

Electricity cost comparison for each year using a base year with an assigned value of 100.

ELECTRICITY INDEX

Electrical Energy Indices comparison for each year using a base year with an assigned value of 100 for the electriicty consumed in that year.

FUELS ENERGY INDEX

Ratio of fuel consumed (in British Thermal Units (BTU's)) to the occupied square footage of OARB.

HEATING DEGREE DAYS

An indication of fuel consumption; one heating degree-day is given for each degree that the daily mean temperature falls below the base of 65°F.

SAVINGS INVESTMENT RATIO (SIR)

The total net discounted savings divided by the total investment, in accordance with ECIP Guidance, dated 6 August 1982.

SIMPLE AMORTIZATION PERIOD (SAP)

The project's capital investment divided by the yearly savings (reduced from energy consumption). The period of time required to recover the initial capital investment.

SOURCE ELECTRICITY ENERGY

Total amount of electricity purchased or total amount produced before line and efficiency losses.

SOURCE ENERGY CONSUMED

Sum of fuels consumed and electricity used (includes all fuels such as heating oil, diesel fuel, natural gas, propane, coal, etc.).

SOURCE ENERGY INDEX

Ratio of source energy consumed (in BTU's) to occupied square footage.

SOURCE INDEX

Comparison of the Source Energy Indices for each year, giving a chosen base year a value of 100.

TOTAL INSTALLED COST (TIC)

The sum of the Current Working Estimate (CWE) and the design costs.

LIST OF ABBREVIATIONS

AAFES	Army Air Force Exchange Service
AECP	Annual Energy Consumption Program
AFEP	Army Facilities Energy Plan (Office of the Chief of Engineers)
APEC	Automated Procedures for Engineering Consultants
Ave	Avenue
BCR	Benefit Cost Ratio
Bldg	Building
BTU	British Thermal Unit
BTUH	British Thermal Unit Per Hour
°C	Degree Centigrade
Cp	Specific Heat
CCU	Central Control Unit
cf	Cubic Foot
cfm	Cubic Foot Per Minute
COE	Corps of Engineers
CO_2	Carbon Dioxide
CV	Constant Voltage
CW	Cold Water
CWE	Current Working Estimate
DD	Degree Days
DOD	Department of Defense
EBMUD	East Bay Municipal Utility District
ECIP	Energy Conservation Investment Program
ECM	Energy Conservation Measure
ECR	Energy to Cost Ratio
EMCS	Energy Monitoring and Control Systems
Est	Estimated
°F	Degree Farenheit
FID	Field Interface Device
Ft	Foot
FY	Fiscal Year
Gal	Gallon
GPM	Gallons Per Minute
GSF	Gross Square Feet
HE	Heat Exchanger
HP	High Pressure
HPS	High Pressure Sodium
Hr	Hour
HVAC	Heating, Ventilating, and Air-Conditioning
IES	Illuminating Engineering Society of North America
INC	Incandescent
KBTU	Kilo British Thermal Unit (KBTU = 10^3 BTU)
KGSF	Kilo Gross Square Feet (KGSF = 10^3 GSF)
KV	Kilo Volt

KVA	Kilo Volt Amp
Kw	Kilowatt
Kwh	Kilowatt Hour
L	Lumens
lbs	Pounds
LPG	Liquified Petroleum Gas
M	Mass Flow Rate
MBTU	Mega British Thermal Unit (MBTU = 10^6 BTU)
MCR	Main Control Room
Min	Minute
Mos	Months
MTMC	Military Traffic Management Command
MUX	Multiplexer
MV	Mercury Vapor
NAF	Non-Appropriated Funds
NC	Normally Closed
NO	Normally Open
OARB	Oakland Army Base
P	Permanent
PG & E	Pacific Gas and Electric
ppm	Parts Per Million
PSI	Pounds Per Square Inch (Absolute)
PSIG	Pounds Per Square Inch (Gage)
PTTC	Pacific Telephone and Telegraph Company
PWC	Public Works Center
Q	Heat Per Time (BTUH's)
Qty	Quantity
REF	Reference
S	Semi-Permanent
SAP	Simple Amortization Period
SIR	Savings Investment Ratio
SC	Series Connected
SIOH	Supervision, Inspection, and Overhead
Sq Ft	Square Foot
T	Temporary
T_1	Final Temperature
T_2	Initial Temperature
Temp	Temperature
TIC	Total Installed Cost
TPD	Tons Per Day
TW	Tempered Water
V	Volts
W	Watts
WC	Water Column
Wk	Week
WSF	Window Square Foot Area
Yr	Year

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

1.1 PROJECT REQUIREMENT

This engineering analysis is undertaken in order to develop a systematic program of projects that will lead to energy consumption reductions at the Oakland Army Base (OARB) without compromising the Base mission, and in compliance with all applicable environmental and Occupational Safety and Health Administration regulations. Reduced energy consumption is a stated goal of the Army Facilities Energy Plan.

The projects included in this analysis are grouped into five increments: A - Energy Conservation Investment Program (ECIP) projects for buildings, B - ECIP projects for utilities and energy distribution systems, C - Solar energy projects, E - Feasibility of central boiler plants, and G - Minor construction, maintenance, and repair projects not ECIP qualified.

1.1.1 Increment A - Energy Conservation Investment Program (ECIP) Projects for Buildings and Processes

Increment A includes those ECIP projects involving modifying, improving, or retrofitting existing buildings or production process facilities.

Projects are evaluated in accordance with ECIP criteria.

Each building or discrete part is analyzed in terms of its design energy consumption. Each energy source entering the building is identified.

1.1.2 Increment B - Energy Conservation Investment Program (ECIP) Projects for Utilities and Energy Distribution

Increment B includes utilities and energy distribution systems, Energy Monitoring and Control Systems for building and distribution systems, and the conversion of existing energy plants. Projects are evaluated in accordance with ECIP criteria. Systems studied include electrical supply and distribution, and steam and hot water distribution systems. The condition and operating efficiencies of the boiler plants are assessed.

1.1.3 Increment C - Solar Energy Projects

In Increment C, solar energy projects are considered for applicability at the Base. The feasibility of using solar energy is explored for space heating, space cooling and domestic hot water.

1.1.4 Increment E - Central Boiler System Projects

Increment E is to determine the practicality and economic feasibility of constructing central boiler plants to supply high pressure steam or high temperature water to all or discrete parts of the

plant. A major objective is to reduce the dependency on petroleum fuel by converting to coal or other solid fuels, such as refuse derived fuels or wood, as the primary energy source. An economic analysis is made and potential savings or increases in energy consumption is documented.

1.1.5 Increment G - Maintenance, Repair and Minor Construction Projects

These projects involve individual, low-capital expenditure, cost-effective and energy efficient projects which merit implementation exclusive of ECIP projects. Increment G projects were identified during Phase I and II of Increments A & B.

2.1 BASE DESCRIPTION AND MISSION

OARB is located within the City of Oakland near the eastern end of the San Francisco-Oakland Bay Bridge. The Base occupies 570 acres of which 192 acres are water area. There are presently 103 buildings and structures. Total building area, including docks, is approximately 3,605,000 square feet (see Figure 1: General Site Map).

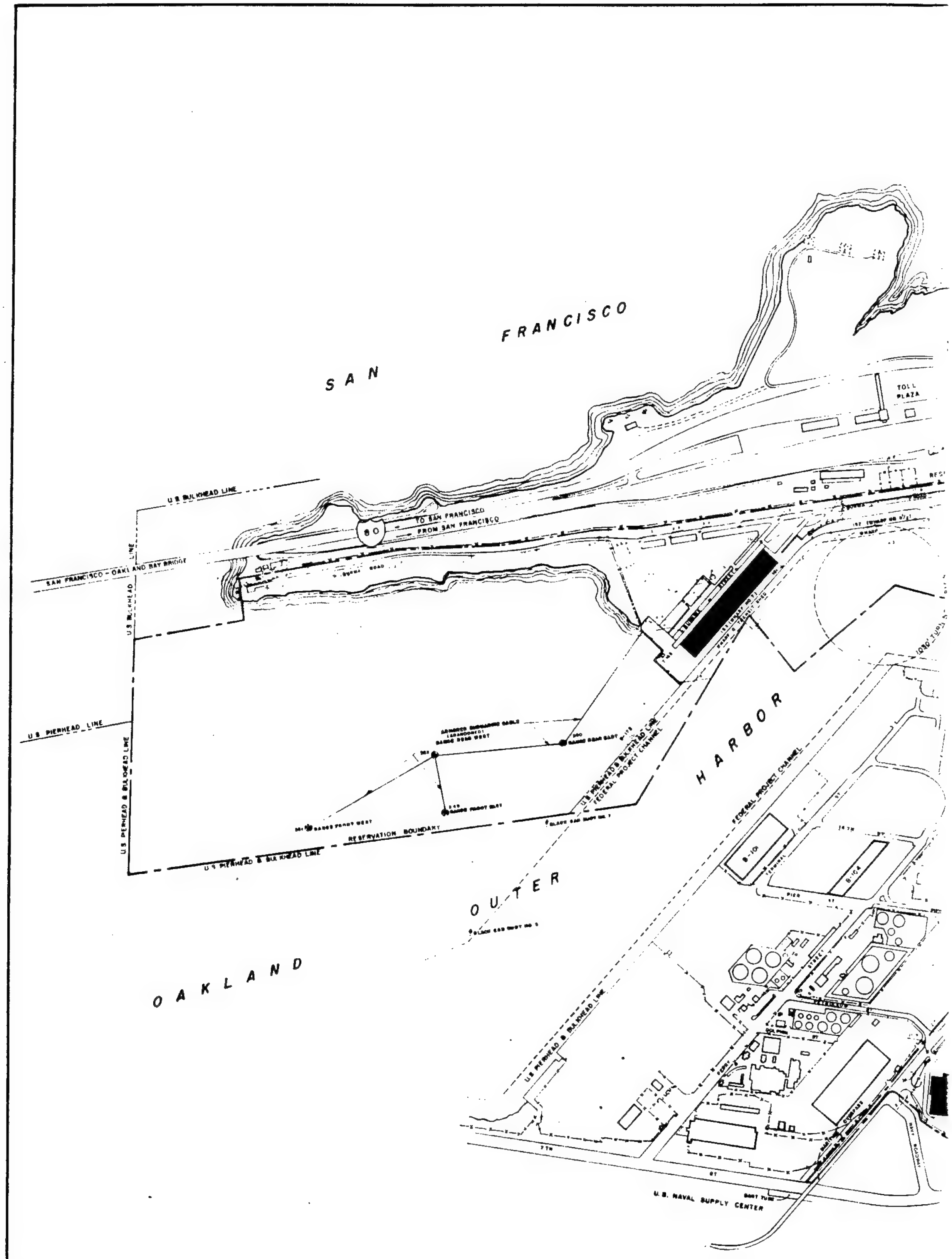
The Base served as a military cargo port during World War II, Korea, and Vietnam. Numerous military tenant agencies occupy Base buildings. They are the Army and Air Force Exchange Service; Western Sector, Military Enlistment Processing Command; U.S. Air Force Water Ports Logistics Office; U.S. Army Transfer Point; U.S. Army Reserve Center; Western Management Information Systems Office; the U.S. Army Communications Command; and the Navy Public Works Center.

The present mission of the Base is that of a military port and transfer station. This mission has been continuous since the Base was established in 1940 and no change in its mission is anticipated. In the event of mobilization, tenants lease will be rcovered under a recovery clause.

3.1 ARMY FACILITIES ENERGY PLAN

The Army Facilities Energy Plan sets short and long range energy goals for the Army and provides policy and planning guidance for the development of detailed facility energy plans. The Army's energy goals are to:

- Reduce total facility energy consumption by at least 20 percent by FY 1985 and by 50 percent by FY 2000, using FY 1975 as the base year.
- Reduce FY 1985 average annual energy consumption per gross square foot of floor area by 45 percent in new buildings compared to FY 1975.
- Derive ten percent of Army facility energy from coal and alternate fuels by FY 1985.



BUILDINGS AND STRUCTURES

1 OARB HEADQUARTERS BUILDING
4 POV AREA, SHIPPING & RECEIVING
6 COMMUNICATIONS & ADP BUILDING
7 FLAG POLE
60 CAFETERIA
70 PROVOST MARSHAL ADMIN
85 PRINTING PLANT
88 GENERAL STOREHOUSE
90 ADMINISTRATION BUILDING
99 QUARTERMASTER REPAIR SHOP
99A GAS STA. W/O BUILDING
121 SENTRY STATION
123 SENTRY STATION
141 TRANSIT SHED WHARF NO 6
143 LUNCH ROOM
145 GENERAL PURPOSE WAREHOUSE
151 WHARF NO. 6
152 WHARF NO. 6½
153 WHARF NO 7
161 TRANSIT SHED WHARF NO 7.
163 LUNCH ROOM
173 DOLPHIN
590 GENERAL PURPOSE WAREHOUSE
640 GENERAL PURPOSE BLDG
641 YOUTH CENTER, THRIFT SHOP PACKAGE LIQUOR STORE
647 DEPENDENT NURSERY SCHOOL
648 STORAGE SHED
650 BARRACKS OIDOTRS COI W/O MESS
660 THEATER W/STAGE
690 SNR ENLIST'D QTRS GUEST HSE
701 CHAPEL
702 SENTRY STATION
726 ENLISTED MENS SERVICE CLUB MAIN LIBRARY
735 STORAGE BLDG
738 CRAFTS SHOP
740 BOWLING CENTER
762 DISPENSARY WO BEDS
780 BARRACKS, ADMIN & COMMUNITY FACILITIES
790 BARRACKS, ENLISTED MEN'S W/MESS
792 BARRACKS, ENLISTED MEN'S W/MESS
794 BARRACKS, ENLISTED MEN'S W/MESS
801 SENTRY STATION
802 GENERAL PURPOSE WAREHOUSE
803 GENERAL PURPOSE WAREHOUSE
804 GENERAL PURPOSE WAREHOUSE
805 GENERAL PURPOSE WAREHOUSE
805A GAS STA W/O BUILDING
806 GENERAL PURPOSE WAREHOUSE
807 GENERAL PURPOSE WAREHOUSE
808 GENERAL PURPOSE WAREHOUSE
810 SENTRY STATION
812 QUARTERMASTER REPAIR SHOP
821 GENERAL STOREHOUSE
822 FLAMMABLE MATERIAL STOREHOUSE
823 QUARTERMASTER REPAIR SHOP
825 CABLE HOUSE
828 PX SERVICE STATION
830 AUTOMOTIVE CRAFT SHOP
831 WASH PLATFORMS
832 GASOLINE STATION
833 ADMIN BUILDING (AFGE UNION
834 DISPATCH OFFICE
835 OIL HOUSE
837 GREASE RACK
838 STORAGE SHED (AUTO CRAFT SHOP)
839 VEHICLE STORAGE
840 QUARTERMASTER REPAIR SHOP
856 ADMINISTRATION BUILDING
905 PUBLIC TOILET
916 SCALE HOUSE
989 STORAGE TANK
990 STORAGE TANK
991 RAILROAD ENGINE SHOP
992 FLAMMABLE MATERIAL STOREHOUSE
995 VEHICLE BRIDGE (28TH ST OVERPASS)
1101 ADMINISTRATION BUILDING
B1 WAITING SHELTER
B2 WAITING SHELTER
B3 WAITING SHELTER
B4 WAITING SHELTER
B5 WAITING SHELTER

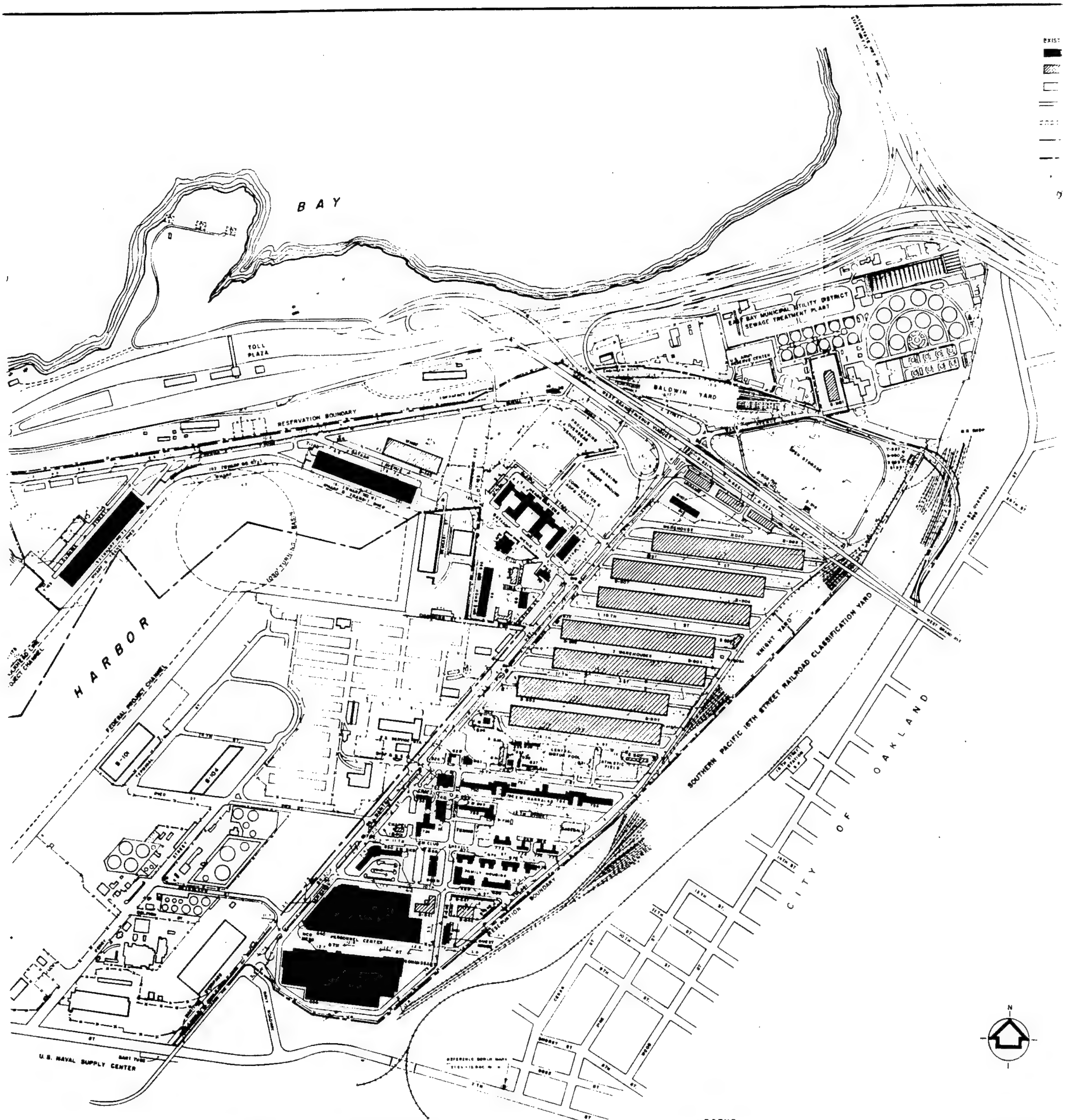
US ARMY RESERVES

1060 ADMINISTRATION BUILDING
1064 MAINTENANCE SHOPS
1068 STORAGE
1069 LOADING PLATFORM
1070 STOREHOUSE
1071 SHOP-OFFICE
1072 FLAMMABLE MATERIAL STOREHOUSE
1073 WASHRACK
1074 STORAGE BUILDING
1076 OPEN WAREHOUSE (STOREH
1080 GREASE RACK
1082 WASH PLATFORM
1084 MAINTENANCE SHOP
1086 ARMY RESERVE CENTER
1088 FLAG POLE

NAVY PUBLIC WORKS CENTER

18 SEWAGE PUMPING STATION
20 ELECTRIC SWITCHING STAT
148 SEWAGE PUMPING STATION
645 OFFICE BUILDING
646 GENERAL STORAGE
663 SEWAGE PUMPING STATION
670 FAMILY HOUSING, CAPEHAR
674 FAMILY HOUSING, CAPEHAR
675 FAMILY HOUSING, CAPEHAR
676 FAMILY HOUSING, CAPEHAR

1



SHOP	991	RAILROAD ENGINE SHOP
	992	FLAMMABLE MATERIAL STOREHOUSE
OREHOUSE	995	VEHICLE BRIDGE (28TH ST OVERPASS)
SHOP	1101	ADMINISTRATION BUILDING
	B1	WAITING SHELTER
	B2	WAITING SHELTER
	B3	WAITING SHELTER
	B4	WAITING SHELTER
NION	B5	WAITING SHELTER
		US ARMY RESERVES
	1060	ADMINISTRATION BUILDING
	1064	MAINTENANCE SHOPS
FT SHOP)	1068	STORAGE
	1069	LOADING PLATFORM
HOP	1070	STOREHOUSE
	1071	SHOP-OFFICE
	1072	FLAMMABLE MATERIAL STOREHOUSE
	1073	WASHRACK

1074	STORAGE BUILDING
1076	OPEN WAREHOUSE (STOREHOUSE BINS)
1080	GREASE RACK
1082	WASH PLATFORM
1084	MAINTENANCE SHOP
1086	ARMY RESERVE CENTER
1088	FLAG POLE
	NAVY PUBLIC WORKS CENTER
18	SEWAGE PUMPING STATION
20	ELECTRIC SWITCHING STATION
148	SEWAGE PUMPING STATION
645	OFFICE BUILDING
646	GENERAL STORAGE
663	SEWAGE PUMPING STATION
670	FAMILY HOUSING, CAPEHART
674	FAMILY HOUSING, CAPEHART
675	FAMILY HOUSING, CAPEHART
676	FAMILY HOUSING, CAPEHART

680	FAMILY HOUSING CAPEHART
689	FAMILY HOUSING CAPEHART
772	FAMILY HOUSING CAPEHART
773	FAMILY HOUSING
774	FAMILY HOUSING
775	FAMILY HOUSING
793	HEATING PLANT, GAS FIRED
796	ADMINISTRATION BUILDING
826	GAS METER STATION
827	ELECTRIC SWITCHING STATION
829	LPG STORAGE TANKS
836	SEWAGE PUMPING STATION

LEGEND

P — PERMANENT
S — SEMI-PERMANENT
T — TEMPORARY

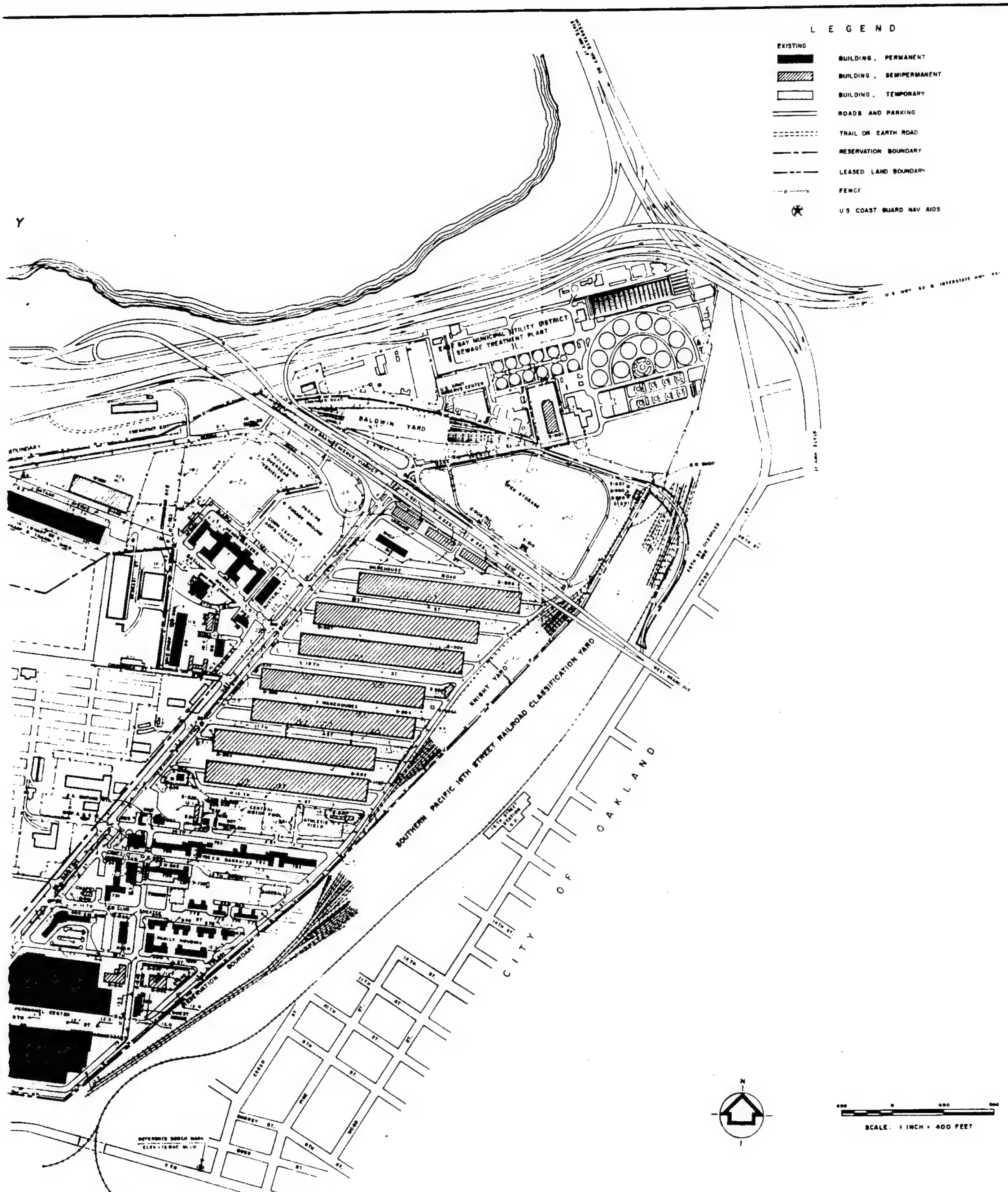
FIGURE

OAKLAND ARM

OAKLAND, CALI

GENERAL SITE
BUILDING AND STRU

2



890 FAMILY HOUSING CAPEHART
889 FAMILY HOUSING CAPEHART
772 FAMILY HOUSING CAPEHART
773 FAMILY HOUSING
774 FAMILY HOUSING
775 FAMILY HOUSING
793 HEATING PLANT, GAS FIRED
796 ADMINISTRATION BUILDING

876 GAS METER STATION
827 ELECTRIC SWITCHING STATION
829 LPG STORAGE TANKS
836 SEWAGE PUMPING STATION

LEGEND

P — PERMANENT
S — SEMI-PERMANENT
T — TEMPORARY

FIGURE 1

OAKLAND ARMY BASE

OAKLAND, CALIFORNIA

GENERAL SITE MAP — BUILDING AND STRUCTURE INDEX

- Derive one percent of Army facility energy from solar energy by FY 1985.
- Eliminate use of natural gas by FY 2000.
- Reduce facility use of petroleum fuel by 75 percent by FY 2000.

4.1 SOURCE ENERGY CONSUMPTION

Table 1: Source Energy Consumption, compares consumption from FY 1975, the base year for the study, with consumption during FY 1979. Total energy consumption over the period remained constant though fuel costs more than doubled. Fuel usage has decreased approximately ten percent though electrical consumption has increased by ten percent. See Figure 2: Energy Use Trends.

TABLE 1

SOURCE ENERGY CONSUMPTION
FY 1975 AND 1979

	FY 1975		FY 1979	
Source	Cost ($000)	MBTU's Consumed (000)	Cost ($000)	MBTU's Consumed (000)
Electricity	$217	155	$464	169
Fuel Oil No. 2	4	3	-0-	-0-
Natural Gas	134	135	321	125
Propane Gas	4	1	3	0.5
Totals	$359	294	$808	294

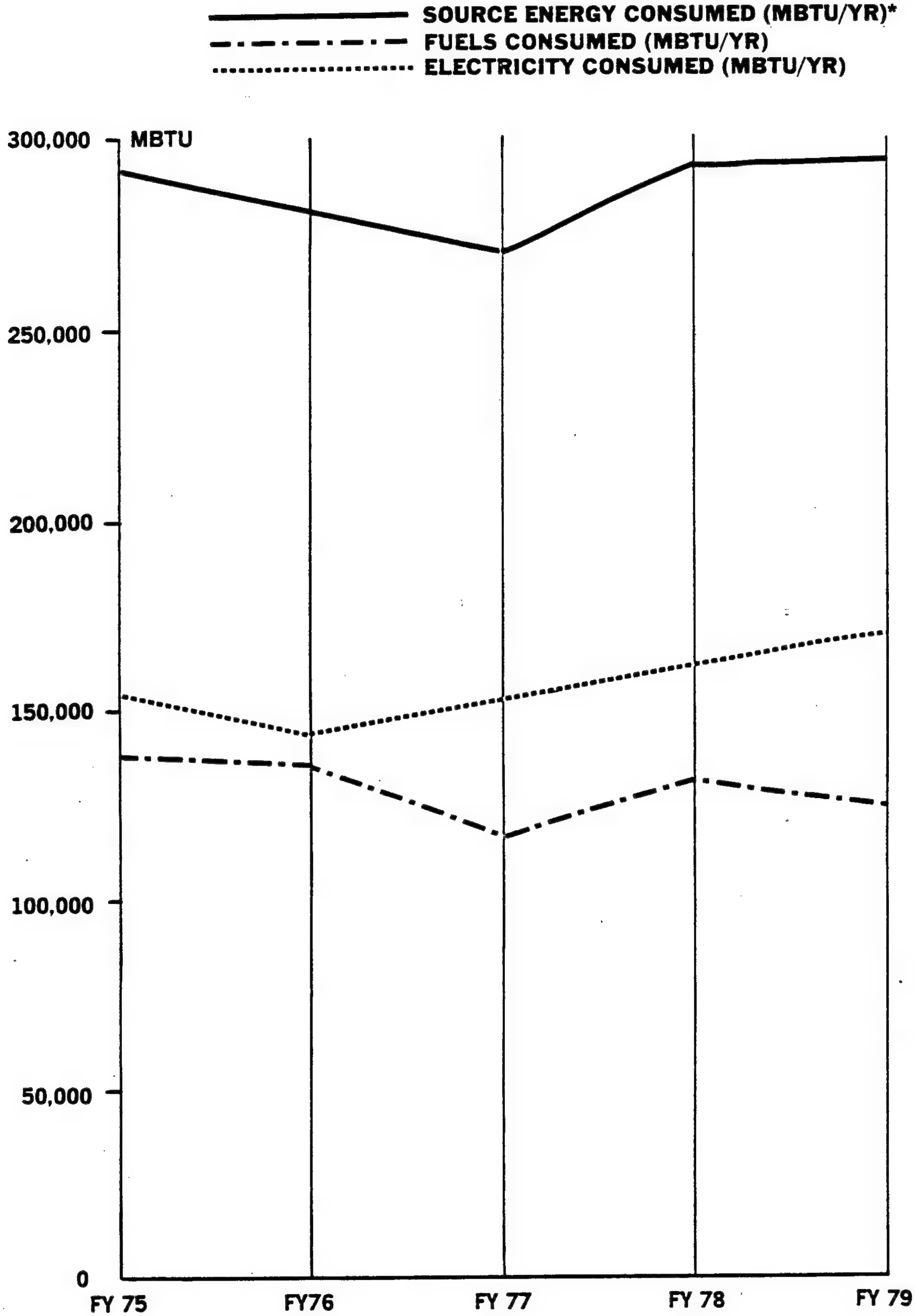
Total fuel consumption is largely affected by heating requirements while the amount of electricity used is affected by cooling requirements.

Figure 3: Gross Square Foot Energy Trends, shows the relationship of source energy, fuels energy, and electrical energy to the gross square footage of Base buildings. The overall Military Traffic Management Command goal is also shown.

5.1 PROJECT EXECUTION

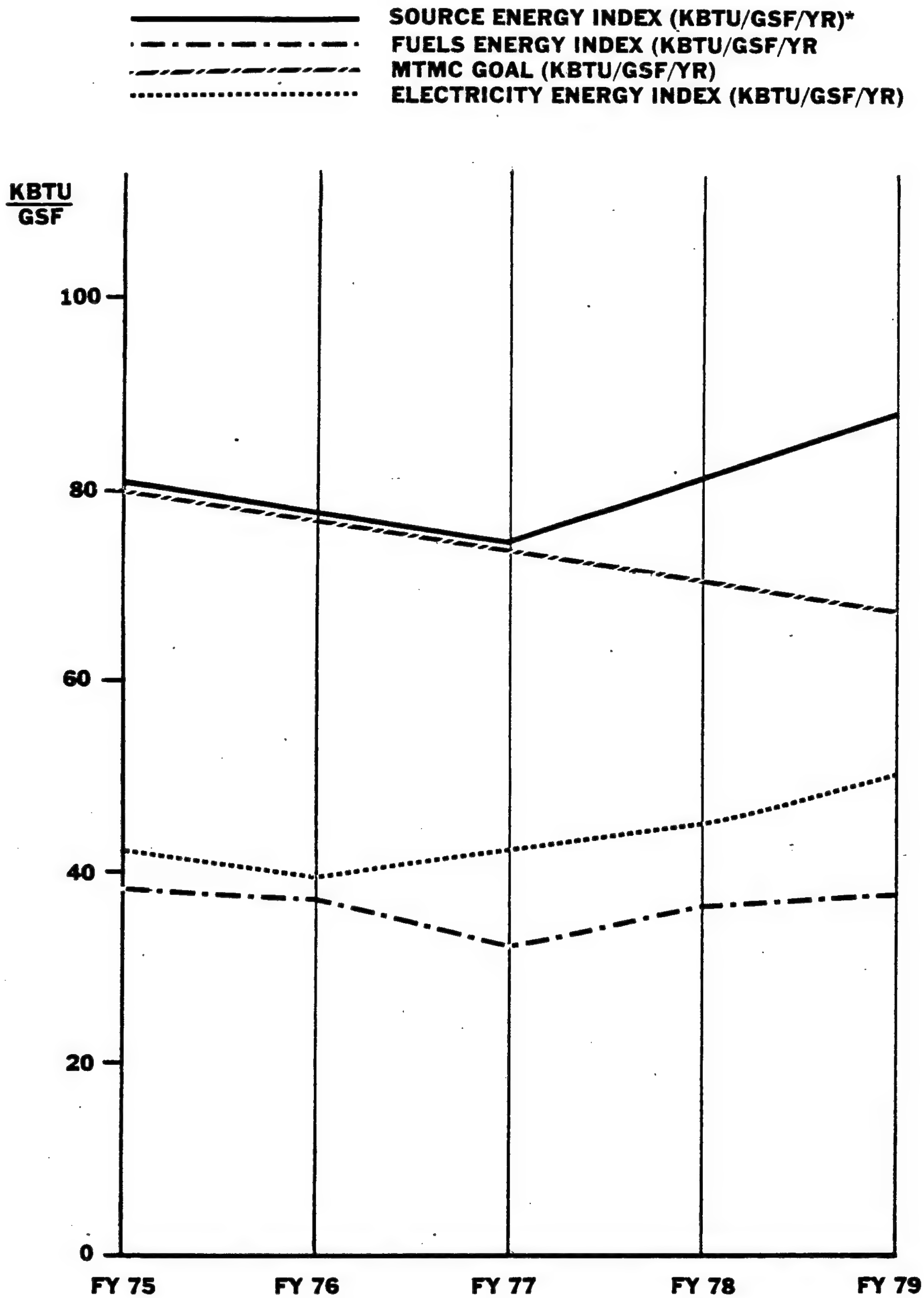
This energy engineering analysis was conducted in three phases:

- Field surveys
- Analysis of projects
- Preparation of Project Programming Documents



*Mega British Thermal Units per Year

FIGURE 2
ENERGY USE TRENDS



*Kilo British Thermal Units per Gross Square Foot per Year

FIGURE 3

GROSS SQUARE FOOT ENERGY TRENDS

5.1.1 Field Surveys and Data Gathering

The field surveys were conducted in four areas:

- Architectural - to evaluate such items as wall and roof types, and levels of insulation.
- Mechanical - to evaluate heating, ventilating, and air conditioning systems
- Electrical - to evaluate lighting and building electrical systems
- Distribution - to evaluate Base utility systems

The distribution surveys covered all Base utility systems including electrical, steam, natural gas, water, sewage, and compressed air.

The survey phase enabled the identification of energy conservation opportunities and the applicability of energy conservation measures to OARB.

A study addressed the feasibility of using solar energy at the Base. Solar domestic hot water projects are presented for consideration.

A study was also conducted to determine the feasibility of utilizing central heating plants. The study revealed that it would be more cost-effective to upgrade the existing plants.

5.1.2 Analysis of Projects

After the data gathering phase it was possible to identify potential projects for analysis. These projects were analyzed for applicability to OARB and their potential to save energy in relation to their implementation cost.

5.1.3 Review and Verification

OARB personnel assisted in the selection of those projects which should be implemented and developed project priorities. All projects were reviewed and verified at the Base in consultation with OARB personnel.

6.1 PROJECTS PROPOSED FOR IMPLEMENTATION

6.1.1 ECIP Projects

The following ECIP Projects are proposed for implementation by Oakland Army Base.

TABLE 2

ECIP PROJECTS SUMMARY

Project No.	Description	Energy Saving MBTU/Yr	TIC*	ECR	BCR	SAP	FY Proposed
1	Weatherstrip and Caulk Windows and Doors	19,540	$ 304,000	64	10	1.2	85
2	Replace Incandescent Fixtures with New Lighting System (805-808, 590)	31,700	1,313,000	24	2.6	6.2	85
3	Add Insulation to Walls and Roofs	8,840	544,000	16.2	3.7	5.1	85
4	Recover Refrigeration System Waste Heat	2,730	240,000	12	1.7	10	85
5	Family Housing Solar Domestic Hot Water	3,100	480,000	6.8	1.1	17.7	85
		65,910	$2,881,000				

*Escalated to the midpoint of construction

6.1.2 Minor Construction, Maintenance, and Repair Projects (Increment "G" Projects)

TABLE 3

INCREMENT G (MINOR CONSTRUCTION, MAINTENANCE AND REPAIR PROJECTS) SUMMARY

Project No.	Description	Energy Saving MBTU/Yr	TIC*	ECR	BCR	SAP	FY Proposed	Man Hours
1	Install Timers on HVAC Equipment	6,190	$ 5,700	1141	114.0	0.1	82	56
2	Reduce Lighting Load in Bldg. No. 85	400	1,000	340	23.0	0.8	82	40
3	Install Insulating Panels in Windows	190	5,300	37	8.5	2.3	82	128
4	Heat Destratification	1,050	46,000	24	1.8	6.9	82	464

TABLE 3 (Continued)

Project No.	Description	Energy Saving MBTU/Yr	TIC*	ECR	BCR	SAP	FY Proposed	Man Hours
5	Install Self-Contained Thermostatic Valves on Radiation	820	54,000	16	1.5	8.4	82	504
6	Day-Night Thermostats Family Housing	230	14,000	17	1.2	10.0	82	320
	TOTAL	9,180	$126,000					

*Escalated to the end of the FY Proposed

6.1.3 Central Boiler Plant Projects (Increment "E" Projects)

The analysis of central heating plant alternatives showed that refitting Existing Boilers was the most feasible alternative.

TABLE 4

INCREMENT E CENTRAL BOILER PLANT PROJECTS SUMMARY

Project Description	Initial Cost	Total Life Cycle Cost
Retrofit Existing Boiler	$1,400,000	$31,600,000
Medium Temperature Hot Water Central Heating Plant	$3,420,000	$31,500,000
Steam Central Heating Plant	$4,010,000	$33,700,000

6.1.4 Increment F Projects

Increment F projects are site specific energy savings modifications and changes in building and system operation which are within the funding authority and management control of the Facilities Engineer. Increment F projects are shown, by descending SIR, on Table 5: Life-Cycle Cost Analysis Summary - Increment F Projects.

TABLE 5

LIFE-CYCLE COST ANALYSIS SUMMARY
INCREMENT F PROJECTS

BUILDING	PROJECT TITLE	PROJECT NO.	TOTAL INITIAL INVESTMENT	MANHOURS	ENERGY SAVINGS MBTU/YR	ANNUAL $ SAVINGS	SIR
P- 99	INSTALL LOCKING THERMOSTAT COVERS	P-99-2	$70	1	2,337.0	$29,259	5055.84
P-590	INSTALL LOCKING THERMOSTAT COVERS	P-590-2	$1,299	20	13,790.0	$172,650	1607.65
P- 60	INSTALL LOCKING THERMOSTAT COVERS	P-60-1	$200	3	1,648.0	$20,632	1247.80
S-823	INSTALL LOCKING THERMOSTAT COVERS	S-823-2	$70	1	529.0	$6,623	1144.43
S-840	INSTALL LOCKING THERMOSTAT COVERS	S-840-2	$70	1	319.0	$3,993	690.00
P-640	INSTALL LOCKING THERMOSTAT COVERS	P-640-1	$1,998	30	8,000.0	$100,159	606.36
S-822	INSTALL LOCKING THERMOSTAT COVERS	S-822-1	$70	1	164.0	$2,053	354.74
S-821	INSTALL LOCKING THERMOSTAT COVERS	S-821-2	$70	2	164.0	$2,053	354.74
S-645	INSTALL LOCKING THERMOSTAT COVERS	S-645-2	$70	1	163.0	$2,040	352.53
P- 70	INSTALL LOCKING THERMOSTAT COVERS	P-70-3	$130	2	291.0	$3,643	338.95
S-701	INSTALL LOCKING THERMOSTAT COVERS	S-701-1	$130	2	151.0	$1,890	175.86
S-833	INSTALL LOCKING THERMOSTAT COVERS	S-833-2	$130	2	143.0	$1,790	166.54
P-689	INSTALL LOCKING THERMOSTAT COVERS	P-689-2	$499	8	480.0	$6,009	145.66
P-773	INSTALL LOCKING THERMOSTAT COVERS	P-773-2	$400	6	360.0	$4,507	136.28
P-775	INSTALL LOCKING THERMOSTAT COVERS	P-775-2	$400	6	317.0	$3,968	119.99
P-774	INSTALL LOCKING THERMOSTAT COVERS	P-774-2	$400	6	317.0	$3,968	119.99
S-803	INSTALL LOCKING THERMOSTAT COVERS	S-803-2	$130	2	76.0	$951	88.50
P-676	INSTALL LOCKING THERMOSTAT COVERS	P-676-2	$499	8	272.0	$3,405	82.54
P-680	INSTALL LOCKING THERMOSTAT COVERS	P-680-2	$999	16	496.0	$6,209	75.18
P-772	INSTALL LOCKING THERMOSTAT COVERS	P-772-2	$799	12	358.0	$4,482	67.85
P-675	INSTALL LOCKING THERMOSTAT COVERS	P-675-2	$799	12	344.0	$4,306	65.19
P-674	INSTALL LOCKING THERMOSTAT COVERS	P-674-2	$799	12	335.0	$4,194	63.49
P-670	INSTALL LOCKING THERMOSTAT COVERS	P-670-2	$799	12	335.0	$4,194	63.49
S-807	INSTALL LOCKING THERMOSTAT COVERS	S-807-3	$130	2	42.0	$525	48.85
S-806	INSTALL LOCKING THERMOSTAT COVERS	S-806-3	$70	1	21.0	$262	45.30
S-822	DISCONNECT UNIT HEATERS	S-822-2	$89	2	25.7	$321	43.62
S-802	DISCONNECT UNIT HEATERS	S-802-3	$89	2	25.7	$321	43.62
P- 70	REPAIR LEAKING FAUCETS	P-70-2	$19	1	5.0	$62	39.42
P-793	INSULATE STEAM PIPING AND VALVES	P-793-2	$280	4	67.6	$846	36.55
P-680	INSTALL FLOW RESTRICTORS ON SHOWER HEADS	P-680-4	$419	8	99.2	$1,241	35.83
P-689	INSTALL FLOW RESTRICTORS ON SHOWER HEADS	P-689-3	$211	4	50.0	$625	35.82
P-676	INSTALL FLOW RESTRICTORS ON SHOWER HEADS	P-676-3	$211	4	50.0	$625	35.82
P-650	INSTALL FLOW RESTRICTORS ON SHOWER HEADS	P-650-1	$1,248	24	291.0	$3,643	35.31
P-640	INSTALL FLOW RESTRICTORS ON SHOWER HEADS	P-640-2	$639	12	149.0	$1,865	35.30
P-790	INSTALL FLOW RESTRICTORS ON SHOWER HEADS	P-790-1	$160	3	37.2	$465	35.15
P-775	INSTALL FLOW RESTRICTORS ON SHOWER HEADS	P-775-3	$160	3	37.2	$465	35.15
P-774	INSTALL FLOW RESTRICTORS ON SHOWER HEADS	P-774-3	$160	3	37.2	$465	35.15
P-773	INSTALL FLOW RESTRICTORS ON SHOWER HEADS	P-773-4	$160	3	37.2	$465	35.15
P-772	INSTALL FLOW RESTRICTORS ON SHOWER HEADS	P-772-3	$319	6	74.0	$926	35.11
P-675	INSTALL FLOW RESTRICTORS ON SHOWER HEADS	P-675-3	$319	6	74.0	$926	35.11
P-674	INSTALL FLOW RESTRICTORS ON SHOWER HEADS	P-674-3	$319	6	74.0	$926	35.11
P-670	INSTALL FLOW RESTRICTORS ON SHOWER HEADS	P-670-3	$319	6	74.0	$926	35.11
P- 70	INSTALL FLOW RESTRICTORS ON SHOWER HEADS	P-70-1	$111	2	24.8	$310	33.79

TABLE 5 (Continued)

LIFE-CYCLE COST ANALYSIS SUMMARY
INCREMENT F PROJECTS

BUILDING	PROJECT TITLE	PROJECT NO.	TOTAL INITIAL INVESTMENT	MANHOURS	ENERGY SAVINGS MBTU/YR	ANNUAL $ SAVINGS	SIR
P-640	INSULATE CONDENSATE SYSTEM	P-640-3	$599	16	124.0	$1,552	31.34
P-762	INSULATE BUILDING HEATING SYSTEM PIPING	P-762-2	$150	4	30.9	$386	31.14
P-690	INSULATE HOT WATER EXPANSION TANK VALVES	P-690-1	$150	4	30.9	$386	31.14
P-650	INSTALL PANEL OVER LOUVER	P-650-2	$230	3	47.0	$588	30.92
P-590	INSTALL PANELS OVER LOUVERED OPENINGS	P-590-3	$32,967	450	6,640.0	$83,132	30.50
P-780	INSULATE CONDENSATE SYSTEM	P-780-3	$963	23	193.0	$2,416	30.34
P-650	COVER LOUVERED OPENING IN LAUNDRY ROOM	P-650-3	$230	3	45.9	$574	30.19
P-590	INSULATE STEAM VALVES AND FLANGES	P-590-4	$190	2	37.7	$472	30.04
P-738	INSULATE HEATING SYSTEM EXPANSION TANK	P-738-2	$100	2	19.3	$241	29.15
S- 90	INSULATE HEATING SYSTEM EXPANSION TANK	S-90-2	$100	2	19.3	$241	29.15
P- 70	INSULATE HEATING SYSTEM EXPANSION TANK	P-70-4	$100	2	19.3	$241	29.15
S-645	INSULATE FURNACE HOT AIR OUTLET DUCT	S-645-3	$239	6	45.3	$567	28.70
P-141	INSTALL LOCKING THERMOSTAT COVERS	P-141-1	$260	4	49.0	$613	28.52
P-726	INSULATE HEATING SYSTEM HEATING TANKS	P-726-1	$120	3	18.0	$225	22.67
P-660	INSULATE HEATING SYSTEM EXPANSION TANK	P-660-2	$120	3	18.0	$225	22.67
P-793	REPAIR STEAM LEAKS	P-793-1	$220	5	29.3	$366	20.12
P-780	REDUCE DOMESTIC HOT WATER TEMPERATURE	P-780-2	$40	1	4.4	$55	16.65
P-590	REPAIR LEAKING STEAM VALVES	P-590-5	$270	6	29.3	$366	16.39
S-802	INSTALL LOCKING THERMOSTAT COVERS	S-802-2	$330	5	27.0	$338	12.39
S-803	REPAIR AIR LEAK	S-803-3	$17	1	5.4	$21	11.84
P-772	INSTALL AQUASTAT	P-772-5	$130	2	35.2	$139	11.38
P-689	INSTALL AQUASTAT	P-689-5	$130	2	35.2	$139	11.38
P-680	INSTALL AQUASTAT	P-680-5	$130	2	35.2	$139	11.38
P-676	INSTALL AQUASTAT	P-676-5	$130	2	35.2	$139	11.38
P-675	INSTALL AQUASTAT	P-675-5	$130	2	35.2	$139	11.38
P-674	INSTALL AQUASTAT	P-674-5	$130	2	35.2	$139	11.38
P-670	INSTALL AQUASTAT	P-670-5	$130	2	35.2	$139	11.38
P- 1	INSTALL AQUASTAT	P-1-2	$265	4	70.8	$281	11.29
P-828	INSTALL PHOTOELECTRIC CONTROLS ON CANOPY	P-828-1	$579	10	149.7	$594	10.55
P-775	INSTALL AQUASTAT	P-775-5	$70	1	17.6	$69	10.51
P-774	INSTALL AQUASTAT	P-774-5	$70	1	17.6	$69	10.51
P-773	INSTALL AQUASTAT	P-773-5	$70	1	17.6	$69	10.51
P-762	INSTALL AQUASTAT	P-762-1	$70	1	17.6	$69	10.51
S-805	INSTALL LOCKING THERMOSTAT COVERS	S-805-2	$260	4	18.0	$225	10.46
S-641	ADJUST COOLER TEMP AND LEVEL	S-641-2	$40	1	10.0	$39	10.38
P-590	INSULATE DOMESTIC HOT WATER SYSTEM	P-590-1	$173	28	40.4	$160	9.84
S-804	INSTALL LOCKING THERMOSTAT COVERS	S-804-2	$260	4	15.0	$187	8.70
P- 88	INSTALL LOCKING THERMOSTAT COVERS	P-88-2	$130	2	7.0	$87	8.09
S- 90	INSULATE DOMESTIC HOT WATER SYSTEM	S-90-1	$1,399	43	69.9	$875	7.57
P-161	INSTALL LOCKING THERMOSTAT COVERS	P-161-1	$200	3	10.0	$125	7.56
S-823	INSULATE DOMESTIC HOT WATER SYSTEM	S-823-1	$409	15	23.8	$297	7.34
P-738	INSULATE DOMESTIC HOT WATER SYSTEM	P-738-1	$719	22	34.4	$430	7.24
P- 1	INSULATE HVAC UNIT PIPING AND DUCT	P-1-3	$850	17	40.7	$509	7.24

TABLE 5 (Continued)

LIFE-CYCLE COST ANALYSIS SUMMARY
INCREMENT F PROJECTS

BUILDING	PROJECT TITLE	PROJECT NO.	TOTAL INITIAL INVESTMENT	MANHOURS	ENERGY SAVINGS MBTU/YR	ANNUAL $ SAVINGS	SIR
S-647	INSULATE DOMESTIC HOT WATER SYSTEM	S-647-1	$489	15	23.4	$292	7.22
S-641	INSULATE DOMESTIC HOT WATER SYSTEM	S-641-1	$489	15	23.4	$292	7.22
P- 99	INSULATE DOMESTIC HOT WATER SYSTEM	P-99-1	$489	15	23.4	$292	7.22
P- 88	INSULATE DOMESTIC HOT WATER SYSTEM	P-88-1	$489	15	23.4	$292	7.22
P-780	INSULATE DOMESTIC HOT WATER SYSTEM	P-780-1	$280	8	12.9	$161	6.96
P-689	INSTALL PHOTOELECTRIC CONTROLS ON STAIRW	P-689-4	$560	12	84.2	$334	6.34
P-680	INSTALL PHOTOELECTRIC CONTROLS ON STAIRW	P-680-3	$560	12	84.2	$334	6.34
P-676	INSTALL PHOTOELECTRIC CONTROLS ON STAIRW	P-676-4	$170	4	28.1	$111	6.22
S-823	REPAIR AIR LEAKS	S-823-3	$77	2	10.4	$41	5.68
P- 1	INSULATE DOMESTIC HOT WATER SYSTEM	P-1-1	$409	8	14.9	$186	5.50
S- 85	INSULATE DOMESTIC HOT WATER SYSTEM	S-85-1	$480	15	16.8	$210	5.29
P-834	INSULATE DOMESTIC HOT WATER SYSTEM	P-834-1	$699	22	24.0	$300	5.19
S-808	INSULATE DOMESTIC HOT WATER SYSTEM	S-808-1	$799	25	27.2	$340	5.15
S-807	INSULATE DOMESTIC HOT WATER SYSTEM	S-807-1	$799	25	27.2	$340	5.15
S-806	INSULATE DOMESTIC HOT WATER SYSTEM	S-806-1	$799	25	27.2	$340	5.15
S-805	INSULATE DOMESTIC HOT WATER SYSTEM	S-805-1	$799	25	27.2	$340	5.15
S-804	INSULATE DOMESTIC HOT WATER SYSTEM	S-804-1	$799	25	27.2	$340	5.15
S-803	INSULATE DOMESTIC HOT WATER SYSTEM	S-803-1	$799	25	27.2	$340	5.15
S-802	INSULATE DOMESTIC HOT WATER SYSTEM	S-802-1	$799	25	27.2	$340	5.15
S-645	INSULATE DOMESTIC HOT WATER SYSTEM	S-645-1	$310	10	10.6	$132	5.15
P-775	INSULATE DOMESTIC HOT WATER SYSTEM	P-775-1	$111	3	3.8	$47	5.13
P-774	INSULATE DOMESTIC HOT WATER SYSTEM	P-774-1	$111	3	3.8	$47	5.13
P-773	INSULATE DOMESTIC HOT WATER SYSTEM	P-773-1	$111	3	3.8	$47	5.13
P-772	INSULATE DOMESTIC HOT WATER SYSTEM	P-772-1	$111	3	3.8	$47	5.13
P-689	INSULATE DOMESTIC HOT WATER SYSTEM	P-689-1	$111	3	3.8	$47	5.13
P-680	INSULATE DOMESTIC HOT WATER SYSTEM	P-680-1	$111	3	3.8	$47	5.13
P-676	INSULATE DOMESTIC HOT WATER SYSTEM	P-676-1	$111	3	3.8	$47	5.13
P-675	INSULATE DOMESTIC HOT WATER SYSTEM	P-675-1	$111	3	3.8	$47	5.13
P-674	INSULATE DOMESTIC HOT WATER SYSTEM	P-674-1	$111	3	3.8	$47	5.13
P-670	INSULATE DOMESTIC HOT WATER SYSTEM	P-670-1	$111	3	3.8	$47	5.13
S-840	INSULATE DOMESTIC HOT WATER SYSTEM	S-840-1	$270	8	9.1	$113	5.06
S-821	INSULATE DOMESTIC HOT WATER SYSTEM	S-821-1	$270	8	9.1	$113	5.06
P-660	INSULATE DOMESTIC HOT WATER SYSTEM	P-660-1	$60	1	1.9	$23	4.63
S-833	INSULATE DOMESTIC HOT WATER SYSTEM	S-833-1	$60	1	1.4	$17	3.43
S-806	DISCONNECT ELEC BASEBOARD HEAT	S-806-2	$31	1	2.3	$9	3.10
S- 4	INSULATE DOMESTIC HOT WATER SYSTEM	S-4-1	$460	11	30.6	$121	2.80
P-740	RECONNECT LIGHTING OVER BOWLING LANES	P-740-1	$2,597	42	146.0	$579	2.37
S-807	DISCONNECT ELECTRIC HEATERS IN UNUSED OF	S-807-2	$33	1	1.8	$7	2.30
P-772	INSTALL PHOTOELECTRIC CONTROLS ON STAIRW	P-772-4	$370	8	18.7	$74	2.13
P-675	INSTALL PHOTOELECTRIC CONTROLS ON STAIRW	P-675-4	$370	8	18.7	$74	2.13
P-674	INSTALL PHOTOELECTRIC STAIRWAY LIGHTING	P-674-4	$370	8	18.7	$74	2.13
P-670	INSTALL PHOTOELECTRIC CONTROLS ON STAIRW	P-670-4	$370	8	18.7	$74	2.13
P-640	INSTALL SOLAR SCREENS	P-640-4	$999	23	50.0	$198	2.11

TABLE 5 (Continued)

LIFE-CYCLE COST ANALYSIS SUMMARY
INCREMENT F PROJECTS

BUILDING	PROJECT TITLE	PROJECT NO.	TOTAL INITIAL INVESTMENT	MANHOURS	ENERGY SAVINGS MBTU/YR	ANNUAL $ SAVINGS	SIR
P-775	INSTALL PHOTOELECTRIC CONTROLS ON STAIRW	P-775-4	$190	4	9.4	$37	2.07
P-774	INSTALL PHOTOELECTRIC CONTROLS ON STAIRW	P-774-4	$190	4	9.4	$37	2.07
P-773	INSTALL PHOTOELECTRIC CONTROLS ON STAIRW	P-773-3	$190	4	9.4	$37	2.07
S-991	INSULATE DOMESTIC HOT WATER SYSTEM	S-991-1	$270	8	7.7	$30	1.19
TOTALS:			$79,557	1490	41,895.3	$514,695	

7.1 INFEASIBLE PROJECTS

TABLE 6

PROJECTS FOUND INFEASIBLE

- Solar domestic hot water
- Solar building heat
- Medium temperature hot water central heating plant
- Steam central heating plant
- Automatic vent dampers in Family Housing
- Lowering the ceiling height in Building No. 640, Transfer Point
- Energy monitoring and control system
- Street lights and area lighting
- Solid waste utilization
- Solar domestic hot water and space heating for Building Nos. 001, 006, 070, 090, 650, 660, 690, 726, 762, 790, 792, 794, 796, 812, 830, and 834.

8.1 SUMMARY OF ALL PROJECTS

TABLE 7

SUMMARY OF PROJECTS

Projects	MBTU Energy Savings	Total Installed Cost ($000)
Proposed ECIP Projects for FY 85	65,910	$2,881
Minor Construction, Maintenance, and Repair Projects (Increment G)	9,160	162
Increment F Projects	41,920	80
Total	116,990	$3,120
Central Boiler Plant Project for FY 85 (Increment E) "Refit Existing Boilers"	---	$1,400

9.1 PROJECTED ENERGY TRENDS

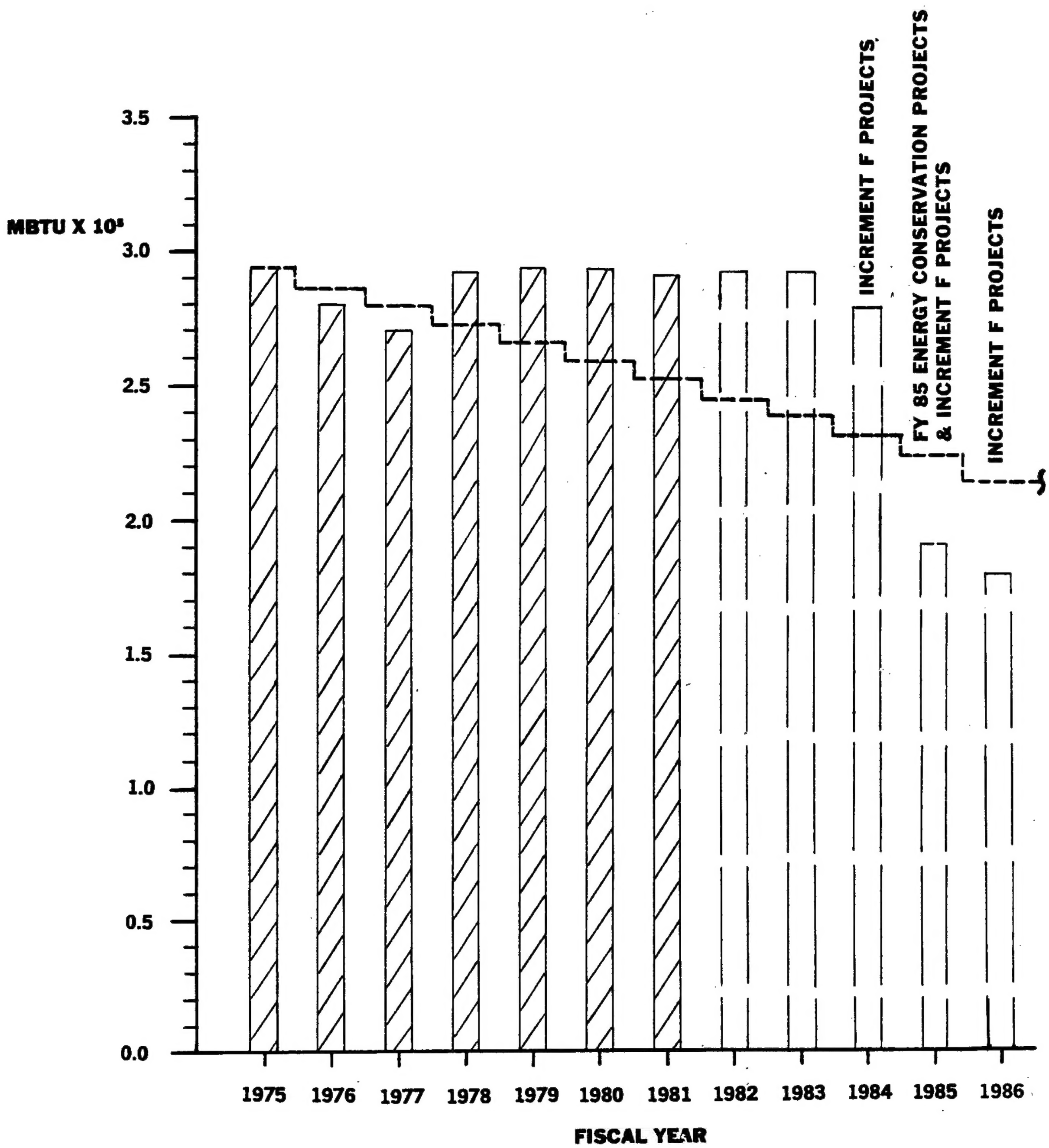
Table 8: Energy Consumption Summary presents historical costs and consumption records for FY 1975 through FY 1979. This shows that costs have more than doubled while consumption has remained fairly constant. Figure 4: Projected Energy Trends, shows the projected trend in energy consumption. As a result of implementing the energy conservation projects, annual energy use will be reduced by approximately 117,000 MBTU's. Building energy use will be reduced from 88 to 53 KBTU's per gross square foot.

TABLE 8
OAKLAND ARMY BASE
ENERGY CONSUMPTION SUMMARY

PARAMETER	UNIT	FY 75	FY 76	FY 77	FY 78	FY 79
Area	GSF	3,621,858	3,621,858	3,621,858	3,587,726**	3,338,873**
Source Energy Consumed	MBTU/Yr	293,119	280,677	270,587	292,485	293,849
Energy Cost	Dollars/Yr	$359,250	$460,375	$681,011	$873,760	$807,575
Source Energy Index	KBTU/GSF/Yr	80.9	77.5	74.7	81.5	88.0
MTMC Goal	KBTU/GSF/Yr	138.7	127.2	120.3	119.2*	118.0*
Energy Cost Index	Dollars/GSF/Yr	$99.19	$127.11	$188.03	$243.54	$241.87
Source Index	Ref. FY 75	100	96	92	101	109
Cost Index	Ref. FY 75	100	128	190	246	244
Fuels Consumed	MBTU/Yr	138,552	136,187	116,967	131,292	125,194
Fuels Cost	Dollars/Yr	$142,302	$212,790	$240,054	$293,088	$323,752
Fuels Energy Index	KBTU/GSF/Yr	38.25	37.60	32.29	36.59	37.50
Fuels Cost Index	Dollars/KGSF/Yr	$39.29	$58.75	$66.28	$81.69	$96.96
Fuels Index	Ref. FY 75	100	98	84	96	98
Fuels Cost Index	Ref. FY 75	100	150	169	208	247
Heating Degree Days	---	2,673	3,214	2,460	1,943	2,651
Heating Fuels Index	BTU/GSF/DD/Yr	14.31	11.70	13.13	18.83	14.15
Electricity Consumed	KWH/Yr	13,324,800	12,456,000	13,243,000	13,896,000	14,539,200
Source Electricity Energy	MBTU/Yr	154,567	144,490	153,620	161,193	168,655
Electricity Cost	Dollars/Yr	$216,948	$247,585	$440,957	$580,672	$483,832
Electricity Energy Index	KWH/GSF/Yr	3.68	3.44	3.66	3.87	4.35
	KBTU/GSF/Yr	42.68	39.89	42.41	44.93	50.51
Electricity Cost Index	Dollars/GSF/Yr	$59.90	$68.36	$121.75	$161.85	$144.91
Electricity Index	Ref. FY 75	100	93	99	105	118
Electricity Cost Index	Ref. FY 75	100	114	203	270	242
Electrical Demand	Peak KW	2,784	2,707	2,937	3,226	3,226
Hours of Usage	---	3,617	4,601	4,509	4,308	4,507

* Interpolated MTMC Goal based on data available in the Army Facilities Energy Plan.

**GSF varies based on the leasing arrangements with the various Non-Government tenants.



LEGEND

HISTORICAL ENERGY CONSUMPTION

PROJECTED ENERGY CONSUMPTION BASED ON FY 80 ACTIVITY & GSF AS CONSTANT AND IMPLEMENTATION OF ECIP PROJECTS

---- OARB ENERGY GOAL (20% REDUCTION FROM BASE YEAR FY 75 THROUGH FY 85)

FIGURE 4

PROJECTED ENERGY TRENDS

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
P.O. BOX 9005
CHAMPAIGN, ILLINOIS 61826-9005

REPLY TO
ATTENTION OF: TR-I Library

17 Sep 1997

Based on SOW, these Energy Studies are unclassified/unlimited. Distribution A. Approved for public release.

Marie Wakefield,
Librarian Engineering